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DIFFERENTIAL USE OF FOOD IN CAPTIVITY BY THE VOLES *MICROTUS MONTANUS* AND *M. LONGICAUDUS* (RODENTIA: ARVICOLIDAE)

The montane vole *(Microtus montanus)* is associated with herbaceous vegetation consisting mainly of grasses or sedges. It is a common inhabitant of montane grasslands in valleys (Findley, J. S. 1987. *The Natural History of New Mexican Mammals.* University of New Mexico Press, Albuquerque. 164 pp.). The long-tailed vole *(M. longicaudus),* on the other hand, is abundant in grasslands which also may include considerable quantities of forbs or short woody shrubs. This vole is also commonly found in small, dispersed, grassy habitat patches or in small isolated alpine meadows within otherwise forested areas [Getz, L. L. 1985. Habitats. Pp. 286-309, *in Biology of New World Microtus.* (R. H. Tamarin, ed.). Spec. Pub. No. 8, American Society of Mammalogists. Lawrence, Kansas. 893 pp.].

In areas where the two species are sympatric, however, the montane vole depresses long-tailed vole populations in shrub habitats, whereas long-tailed voles exclude montane voles from grasslands (Randall, J. A. and R. E. Johnson. 1979. Population densities and habitat occupancy by *Microtus longicaudus* and *M. montanus. J. Mamm., 60:* 217-219). Competition has been proposed as the mechanism that tends to separate two or more coexisting arvicolids. There is considerable evidence that competition between species of *Microtus* influences the habitat utilization of several species of these voles [Douglass, R. J. 1976. Spatial interactions and microhabitat selection of two locally sympatric voles, *Microtus montanus* and *M. pennsylvanicus. Ecology, 57:* 346-352; Rose, R. K. and E. C. Birney. 1985. Community Ecology. pp. 310-339, *In:* R. H. Tamarin, (ed.). *Biology of New World Microtus* Spec. Pub. No. 8, American Society of Mammalogists. Lawrence, Kansas.]

The montane vole *(Microtus montanus)* and the long-tailed vole *(M. longicaudus)* are sympatric species in the meadows of the surroundings of the Rocky Mountain Biological Laboratory, in the Rocky Mountains of Colorado (Armstrong, D. M. 1972. Distribution of mammals in Colorado. *Univ. Kansas, Mus. Nat. Hist. Monog.* 3, 415 pp.). These arvicolids are remarkably alike, except for the comparatively longer tail of *M. longicaudus* (Hall, E. R. 1981. *The Mammals of North America.* 2ad ed. John Wiley & Sons, New York. 2: 1181 + 90 pp.); furthermore, they have very similar natural histories. Like other species of American voles, the diet of these small mammals consists principally of grasses (Lindroth, R. L. and G. O. Batzli. 1984. Food habits of the meadow vole *(Microtus pennsylvanicus)* in blue grass and prairie habitats. *J. Mamm., 65:* 600-606; Matamoros, G. J. 1990. *Estudio sobre la variación de la dieta de una comunidad de roedores del Ex-Lago de Texcoco, México.* Tesis de Licenciatura, Facultad de Ciencias, UNAM. México, D.F. 63 pp.), although they may also feed upon bark, fungi, berries and seeds (Armstrong, D. M. 1975. Rocky Mountains mammals. *A. handbook of mammals of Rocky Mountain National*

Park and Shadow Mountain National Recreation Area, Colorado. Rocky Mountain Nature Association and National Park Service, U. S. Departament of the Interior. Estes Park, Colorado. 174 pp.; Bangs, E. E. 1984. Summer food habits of voles, *Clethrionomys rutilus* and *Microtus pennsylvanicus,* on the Kenai Peninsula, Alaska. *Canadian Field-Nat., 98:* 489-492).

Therefore, montane voles and long-tailed voles have similar food and habitat requirements. It would be expected, however, that habitat partitioning would promote differential habitat utilization by these voles allowing their coexistence. It has been shown that differences in diet partially allow coexistence between ecologically similar vole species (Bangs, 1984; Zimmerman, E. G. 1965. A comparison of habitat and food of two species of *Microtus. J. Mamm., 46:* 605-612). If the coexistence of *Microtus montanus* and *M. longicaudus* is related to habitat partitioning, their ecological separation may be influenced by the differential use of food resources. We thus expected that the montane vole and long-tailed vole would differentially use their food resources. To address this prediction we tested vole individuals in captivity.

From 22 July to 30 July six montane voles and five long-tailed voles (table 1) were collected live with Sherman traps in a meadow 0.5 mi S of Gothic, site of the Rocky Mountain Biological Laboratory, Gunnison Co., Colorado, U.S.A., at 9,500 feet. The voles were transported to Gothic and housed at the RMBL facilities. Each vole was maintained in a separate cage in the laboratory.

TABLE 1
MONTANE VOLES *(MICROTUS MONTANUS)* AND LONG-TAILED VOLES *(M. LONGICAUDUS)* COLLECTED IN A MEADOW 0 5 MI S OF GOTHIC, GUNNISON CO., COLORADO, USA, 9,500 FEET, AND USED IN FEEDING TRIALS

Vole number	*Species*	*Sex*	*Age*	*Weight (g)*	*No. of trials run*
1	Montane vole	F	Adult	44.9	3
2	Montane vole	M	Adult	40.5	2
3	Montane vole	F	Subadult	35.7	2
4	Montane vole	M	Subadult	37.3	1
5	Montane vole	F	Adult	57.8	1
6	Long-tailed vole	F	Subadult	34.8	3
7	Long-tailed vole	F	Adult	50.4	3
8	Montane vole	F	Adult	47.7	5
9	Long-tailed vole	M	Adult	46.3	2
10	Long-tailed vole	F	Adult	44.3	1
11	Long-tailed vole	M	Adult	50.3	1

F = Female, M = Male.

Thirteen common plants of the meadow were collected using conventional procedures, and identified and compared at the RMBL herbarium following Weber (1976. *Rocky Mountain Flora, a field quide for the identification of the ferns, conifers, and flowering plants of the Southern Rocky Mountains from Pikes Peak to Rocky Mountain National Park and from the Plains to the Continental Divide.*

Colorado Associated University Press, Boulder, Colorado. 479 pp.). Fresh individuals of the same plant species were collected and immediately taken to the laboratory to be used in the feeding trials with the voles. The plants were weighed and offered in similar proportions as members of two distinct sets to single voles. Set A comprised the following plant species: *Helianthus nuttallii, Lupinus argenteus, Ligusticum porteri, Ipomopsis aggregata, Veratrum californica,* and *Bromus richardsonii.* Set B included *Vicia americana, Frasera speciosa, Delphinium barbeyi, Potentilla gracilis, P. fructicosa, Poa pratensis,* and *Salix* sp. At the end of a feeding trial the reamining plant material left was weighed by species again.

Some voles were used only once, while the rest were used in up to five different trials (table 1). The voles were not fed until they were used in the trials the following evening after their capture, nearly 14 h later. In total, 24 trials were run, each 25 minutes long. The amount (grams) of the plant eaten and the time (seconds) elapsed since the first to the last bite of a plant species were recorded to know the preference ranking.

Of 13 plant species available to the captive voles, the montane voles ate nine, including the grass *Bromus richardsonii* (table 2). The long-tailed voles ate only five species, all of which were also eaten by the montane voles, and did not consume the grasses *Bromus richardsonii* and *Poa pratensis. Veratrum californica, Potentilla fruticosa, Poa pratensis,* and *Salix* sp. were not consumed by any vole. In both sets of plant species used in the trials at least one food item was not tried by either vole species.

TABLE 2
PLANT SPECIES EATEN, AND ORDER OF PREFERENCE, BY CAPTIVE MONTANE VOLES (*MICROTUS MONTANUS*) AND LONG-TAILED VOLES (*M. LONGICAUDUS*), FROM A MEADOW 0.5 MI S OF GOTHIC, GUNNISON CO., COLORADO, USA., 9,500 FEET

Order	*Montane vole*	*Long-tailed vole*
1	*Helianthus nuttallii*	*Vicia americana*
2	*Vicia americana*	*Lupinus argenteus*
3	*Lupinus argenteus*	*Helianthus nuttallii*
4	*Ligusticum porteri*	*Delphinium barbeyi*
5	*Frasera speciosa*	*Ligusticum porteri*
6	*Delphinium barbeyi*	
7	*Ipomopsis aggregata*	
8	*Bromus richardsonii*	
9	*Potentilla gracilis*	

The order of preference for the food items eaten by the two species of voles was different (table 2). *Helianthus nuttallii* was the most consumed food item by montane voles while it ranked third in the preference of long-tailed voles. The *Vicia americana-Lupinus argenteus* pair were the second and third preferred items by the montane voles, while the same pair were the first and second most eaten plant species by the long-tailed voles. Moreover, *Delphinium barbeyi* ranked two posi-

tions higher in the preference of montane voles than for long-tailed voles. *Frasera speciosa,* one of the most common forbs of the meadow, ranked fifth for montane voles while long-tailed voles did not even try it.

When both species of voles ate the same items they did so in different proportions (table 3). Montane voles always spent longer feeding time upon any of the five plant species than did long-tailed voles. Similarly, montane voles also ate larger amounts of those food items, with the exception of vetch *(Vicia americana). Helianthus nuttalli* was, by far, the most consumed forb of this set by montane voles, while the highest intake by long-tailed voles was for the fairly common forb *Vicia americana.*

TABLE 3
AVERAGE AMOUNT CONSUMED AND TIME SPENT FEEDING ON THE PLANT SPECIES OVERLAPPED IN THE DIET OF CAPTIVE MONTANE VOLES *(MICROTUS MONTANUS)* AND LONG-TAILED VOLES *(M. LONGICAUDUS),* FROM A MEADOW 0.5 MI S OF GOTHIC, GUNNISON CO., COLORADO, USA, AT 9,500 FEET

Plant species	*Montane vole*		*Long-tailed vole*	
	(grams)	*(seconds)*	*(grams)*	*(seconds)*
Helianthus nuttallii	13.41	635	3.28	230
Vicia americana	8.45	1337	10.91	840
Lupinus argenteus	7.10	164	4.04	83
Ligusticum porteri	4.86	245	1.14	15
Delphinium barbeyi	2.95	22	1.44	15

There were clear differences in plant species used as food by both species of voles. Furthermore, the order of preference of the food items was clearly different. The plant biomass consumed by each species showed that although food choices overlapped, the intake was quite different. Montane voles and long-tailed voles thus showed a differential use of food in captivity.

Similar findings were reported for northern red-backed voles *(Clethrionomys rutilus)* and meadow voles *(M. pennsylvanicus),* which coexist in south-central Alaska, feeding on different food items. When they both ate the same items, the proportions were completely dissimilar (Bangs, 1984). Further evidence was reported when the habitat and food of the sympatric prairie vole *(M. ochrogaster)* and meadow vole *(M. pennsylvanicus)* were compared (Zimmerman, 1965). Prairie voles ate a greater variety and higher proportions of each food than did meadow voles. However, it was also found that each species of vole was using a different space of the same habitat.

Therefore, based on the results of the present study and evidence from the literature, it is likely that differential use of the food resources may be playing a significant role leading to the ecological separation and coexistence of these voles under natural conditions. Additional work related to the differential use of their microhabitat would lead to the comprehensive knowledge of their habitat partitioning. Further research should provide insight into these predictions.

Finally, a better knowledge of the food habits of these rodents and its ecological

importance could be significant to wildlife management. Rodent management can be an important economic consideration in reforestation programs, and rodent dispersal of fungi spores is important in promoting the symbiotic relationships between mycorrhizal fungi and higher plants (Bangs, 1984).

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FERNANDO A. CERVANTES.* Departamento de Zoología, Instituto de Biología, UNAM, Apartado postal 70-153, 04510 México, D.F. México.